

# The Hybrid (Wind and Solar) Renewable Energy Resources in Distribution System: A Current Status

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**Abstract:** *In recent years, hybrid solar wind energy has become one of the most significant and promising sources of renewable energy, which requires an additional transmission capability and safer means of maintaining system voltages and reliability. With a large number of distributed generation access, the impact of distributed generations of the grids' security, reliability and stability cannot be ignored. A renewable hybrid energy system consists of two or additional energy sources, an influence learning instrumentality, a controller and an elective energy storage system. These hybrid energy systems have become common in remote space power generation applications as a result of advancements in renewable energy technologies and substantial rise in costs of rock oil merchandise. Analysis and development efforts in star, wind, and alternative renewable energy technologies are needed to continue for, up their performance, establishing techniques for accurately predicting their output and faithfully group action them with alternative standard generating sources. The aim of this paper is to review this state of the planning, operation and management demand of the complete PV solar-wind hybrid energy systems with standard backup supply i.e. diesel or grid. This Paper additionally highlights the longer term developments, which have the potential to extend the economic attractiveness of such systems and their acceptance by the user. The purpose of this work is the development of a solar-wind hybrid power system that harnesses the renewable energies in the Sun and Wind to generate electricity.*

**Keywords:** Renewable Energy, PV-solar, Wind Generation, Wind Turbine, Distribution Grid.

## 1. Introduction

Energy is playing an important role in human and economic development. One of the driving forces of social and economic development and a basic requirement of the nation is energy. Most of the energy production methods are one-way, which cries for an alteration of form for the push. In parallel to developing technology, demand for more energy makes us seek new energy sources. In parallel to developing technology, demand for more energy makes us seek new energy sources. Researches for renewable energies have been initiated first for wind power and then for solar power. The efficiency of solar power conversion systems is ca. 18%, whilst that of wind power is ca. 55%.

Wen Shao, Buhang Zhang, Chenxiong Mao, Yizhe Chen, Biao Mao, Yi Chen, Jie Zeng, Xun Chen [1], presented With a large number of distributed generations' access, the impact of distributed generations to the grids' security and stability cannot be ignored. The micro-grid is a good solution to the approach. This paper makes the asynchronous wind turbine and the microgrid model based on Matlab/Simulink simulation platform.

Arjun A. K., Athul S., Mohamed Ayub, Neethu Ramesh, and Anith Krishnan [2], presented one of the primary needs of socioeconomic development in any nation in the creation is the provision of reliable electricity supply systems with lower carbon footprint levels. The aim of this study is the maturation of a Solar-Wind hybrid Power system that harnesses the renewable energies in the Sun and Wind to generate electricity.

Ghassan Halasa [3], presented the electrical power generation using solar- and wind-energy for the country of Jordan. Presently, with the oil prices are on the ascent, the cost of electrical power output is really gamey. The prospect of a large wind and solar hybrid power

production is being explored. Sights are chosen to produce electricity using, the wind in the Mountains.

Ugur Fesli, Raif BAYIR, Mahmut OZER [4], presented the most important application field of this search is renewable energy resources. Wind and solar energy have being popular ones owing to abundant, ease of availability and convertibility to the electric energy. This work covers realization of a hybrid renewable energy system for a domestic application, which runs under a microcontroller to utilize the solar and wind power.

Chaitanya Marisarla, K. Ravi Kumar [5], presented paper proposes a hybrid energy system consisting of wind, photovoltaic and fuel cell. Battery storage is designed to supply continuous power and to provide the deficit power when the combined wind and photovoltaic sources cannot meet the net load demand. Ch. Breyer, S. Rieke, M. Sterner, J. Schmid [6], presented Solar and wind resources are abundantly available on earth, enabling the usage of photovoltaic (PV) and wind energy technologies on a large scale in most neighborhoods in the Earth. This paper aims at investigating a global energy supply scenario based of PV and wind power supported by an appropriate energy.

Saeed Jahdi, Loi Lei Lai, Daneil Nankoo, [7] given the role of Renewable Energy power sources is the best possible solution today to reduce the increased danger of global warming and the most important type of renewable is Wind and Solar energies which are the most effective. The green power generation resources use power generators in Distributed Generation (DGs) sources that are in direct relation with the function of micro capacity power generating units of power arrangement that are installed in distribution level of power systems or all segments that loads and energy consumers are placed. Balamurugan T., Manoharan S., [8] reported the optimum Power Flow internal control for Grid Connected

Photovoltaic/Wind turbine/ Diesel generator (GCPWD) Hybrid System with hybrid storage system. The energy system having a photovoltaic (PV) panel, turbine (WT) and diesel generator (DG) for continuous power flow management. A diesel generator is additional to make sure uninterrupted power provide owing to the discontinuous nature of star and wind resources. The developed Grid Connected Photovoltaic/Wind turbine/ Diesel generator (GCPWD) Hybrid System has been went to give continuous power to the AC/DC hundreds. A Grid Connected Photovoltaic/Wind turbine/ Diesel generator (GCPWD) hybrid systems three power sources (PV, turbine and diesel generator) and two power sink (AC&DC loads).

Boucetta. Abdallah, Labeled. Djamel [9], conferred an efficient use of renewable energy attracts a good deal of attention globally to address the environmental and resource issues, especially, to cut back greenhouse gas emission, AN inappropriate application of distributed generators may be a reason behind insecure power provide as an example. However, these renewable energy sources suffer from some deficiencies once used as standalone energy sources. the ability generated by WT and PV systems is very keen about weather. Natural variations in wind speed and daylight causes power fluctuations in WT and PV systems, severally. additionally, it's tough to store the ability generated by a PV or WT system for future use. during this paper deals with power management of a wind and star hybrid generation system for interconnection operation with electrical distribution system .

Thanaa F. El-Shatter, Mona N. Eskander, Mohsen T. El-Hagry [10], presented, AN energy system comprising 3 energy sources, namely PV, wind and fuel cells, is recommended. to each one of the 3 energy thusources is controlled so on hand over energy at optimum potency. formal logic management is employed to succeed in most power trailing for each PV and wind energies and to deliver this most power to a set DC voltage bus. The mounted voltage bus provides the load, whereas the surplus power feeds the water electrolyzer wont to generate atomic number one for supply the fuel cells. A management organization is planned to handle the force flow between the system parts so as to satisfy the load necessities throughout the solid day. A case study is dead utilizing the sensible information from the El-Hammam suite (40 kilometre west of Alexandria, Egypt). The survey determines the force generated by the wind and PV systems, the generated atomic number 1 used and keep in tanks and therefore the force generated by the fuel cells to provide the inadequacy within the load demand. Simulation results, in serious trouble two seasons, well-tried the accuracy of the formal logic controllers. Likewise, an ideal description of the management system is shown.

Wind energy is that the K.E. related to the motion of atmospherical air. it's been practiced for many years for sailing, grinding grain and for irrigation. Current of air energy systems convert this K.E. into additional helpful patterns of force. Current of air energy systems for irrigation and edge are in use since precedent days and at

the point in time of the twentieth century it's being applied to come up with power. Windmills for water pumping are put in in several countries significantly within the rural areas. Wind turbines remodel the energy within the wind into mechanical force, which may then be applied directly for grinding, etc. or any changing to power to urge electricity. Wind turbines may be used separately or in clusters referred to as 'wind farms' [7, 9, 10].

Solar energy is directly from the Sun. it's renewable, inexhaustible and environmental pollution free. star charged battery systems give power provide for a whole twenty four hours on a daily basis notwithstanding unhealthy conditions. By taking the acceptable technology for the involved geographical location, we are able to remove a significant live of power from star radiations. what is more solar power is needed to be the foremost promising alternate supply of vitality. the world search and therefore the rise within the worth of typical fuel is making supply-demand of the electricity product nearly not possible significantly in some remote regions. Generators, that square measure oftentimes used as AN choice to typical power provide schemes, square measure proverbial to be run alone throughout sure hours of the day, and therefore the value of felling them is additional and additional obtaining tough if they're to be used for business uses. there's a growing awareness that renewable energy like electrical phenomenon system and wind generation have a crucial role to play so as to avoid wasting things [5, 9]. Hybrid facility accommodates a mix of renewable energy supply like wind generators, solar, etc. of charge, batteries and supply power to fulfil the energy demand, taking the native earth science and alternative details of the place of initiation. These styles of systems aren't blocked in to the most utility facility. they're too used in complete applications and work severally and dependably. the simplest applications for these styles of systems square measure in remote things, like rural villages, in telecommunications, etc. The importance of hybrid systems has grownup as they seem to be the right account a clean and distributed energy production. As AN initial step towards the event, we tend to shall extend the road lighting round the main blocks of the school, that presently draw power from the electricity board provide lines.

The speedy development of star and wind powers is due partially to favourable world political climate towards these energies, efforts to cut back carbonic acid gas (CO<sub>2</sub>) and greenhouse gases (GHG) and alternative powerhouse pollutants, world awareness of mood changes, and therefore the urgency to amass renewable energy sources. alternative ingredients like moneymaking tax incentives and legislation mandating national renewable energy standards have accelerated the march towards star and wind energies. for example within the America, some nations have enacted "renewable portfolio commonplace (RPS)" law that entails utilities to sell a particular % of the energy from property energy sources at intervals cheap stipulated times. despite the fact that Europe and North America have the biggest put in capability of turbine capability, China, India, and developing world bear the biggest potential for wind generation [5, 7, 9].

One of the foremost promising applications of renewable energy technology is that the installation of hybrid energy systems in remote areas, where the grid extension is expensive and also the price of fuel will increase drastically with the remoteness of the placement [10, 11]. Recent analysis and development in Renewable energy sources have shown wonderful potential, as a sort of supplementary contribution to traditional power generation systems [12, 13, 20]. So as to meet sustained load demands throughout variable natural conditions, completely different energy sources and converters ought to be integrated with one another for extended usage of other energy. Renewable energy sources, like electrical phenomenon, wind energy, or tiny scale hydro [28-32], give a practical various to engine-driven generators for electricity generation in remote areas [14-17]. It's been incontestable that hybrid energy systems will considerably scale back the overall lifecycle price [18-19] of standalone power provides in several things, whereas at an equivalent time providing an additional reliable provide of electricity through the mix of energy sources [23, 44]. The wide used term hybrid energy system (HES) describes a complete energy system [24-27], which mixes renewable and standard energy sources with lead-acid batteries for chemical storage, power learning instrumentality and a controller. The controller and power learning units [33-36] square measure wont to maintain the grid quality power, or else, such systems are referred to as integrated renewable energy systems (IRES) [37, 38].

Various hybrid energy systems are put in [39-42] in several countries over the last decade, leading to the event of systems that may compete with typical, fuel based mostly remote space power provides in several applications. Analysis has centered on the performance analysis [42, 43] of demonstration systems and also the development of economical power converters, like bi-directional inverters, battery management units, most point trackers [41, 38]. varied simulation programs [31] square measure obtainable, which permit the optimum size of hybrid energy systems.

The recent state of art hybrid energy system technological development is that the results of activities in a very range of analysis areas, such as:

- Advances in electric power conversion through the supply of recent power electronic semiconductor devices, have semiconductor diode to improved potency, system quality and reliableness.
- Development of versatile hybrid energy system simulation software; continued advances within the producing method and improve potency of electrical phenomenon modules.
- The development of tailor-made, automatic controllers, that improve the operation of hybrid energy systems and scale back maintenance needs.
- Development of improved, deep-cycle, lead-acid batteries for renewable energy systems.
- Availability of additional economical and reliable AC and DC appliances, which may recover their extra price over their extended operational period.

- The task for the hybrid energy system management is to regulate the interaction of varied system elements and control power flow among the system to produce a stable and reliable supply of energy.

With the wide unfold introduction of net-metering, the utilization of tiny isolated or grid connected hybrid energy systems is predicted to grow staggeringly within the close to future. The aim of this paper is to review this state of the planning and operation of hybrid energy systems, and to gift future developments, which is able to enable an extra growth of markets, each in industrialised and developing countries.

## 2. Need of Hybrid System

In present days, hybrid technology has developed and upgraded its role in renewable energy sources whereas the advantages it produces for autonomous power production are unquestionable. Today many homes in rural and concrete areas use hybrid systems. Several isolated islands try and adopt this sort of technology owing to the advantages which may be received as compared with one renewable system. As has been antecedent explained this method employed in my project relies upon a wind ducted rotary engine and PV panels, it's perform is analogous to the image below. This specific hybrid system presents several edges. A lot of specifically for a wind/solar hybrid system the assessment is concentrated on the wind and star potential of the region. so it may be operated throughout the day victimisation the energy from the sun and once the sun has set it will apply the potential wind energy to continue its perform. For this reason, wind and star systems work well along during a hybrid system and that they offer a lot of consistent year-around output than either wind-only or PV-only systems. Furthermore with the employment of the suitable auxiliary systems like batteries you'll store energy which can be helpful in compensating electrical demands utilized by the building for periods wherever there's no sun or wind. Finally, it's economically sound and advantageous to use non finite resources, i.e. star and wind (hybrid). The investment financially and environmentally in fashionable technologies can win through the generations to return within the fight for energy potency and effectiveness.

## 3. Problem Statement and Objectives

The conventional control system on a current high voltage distribution network put forward great advantages. The reserve conditions of an interconnected generator to a high-voltage distribution network are dramatically diminished. Traditional power plant design can be sized to provide buyer loads only, and the power flow only from power plant to customers. In recent few years, the micro-grid power system is becoming more popular, and the great advantages such as low gas emission, high energy efficiency and flexible energy delivery have attracted many stock holders.

Currently several researches are being undertaken into micro-grid. When a number of renewable energy resources are linked to form a power system, the system

behaviour is unstable, some complexity encountered, including dealing with under voltage and over voltage, phase switch, and frequency and power quality problems. So, break down the numerical model of the organization and get an appropriate control strategies become vital for researching the micro-grid power system. Simulation the operation parts of such a grid power system can help frame, the control system for the power system. To supervise the daily load demand also can help to attain better balance between power demand and power supply. These works are primarily concentrated along the hybrid generation (solar and wind energy) system modelling with distribution-grid, as easily as the dynamic synchronization and resynchronization with the distribution network when it's necessary, which are the one of the characters of such a micro-grid power system.

Referable to the ever-increasing need for power consumption and mounting public awareness of the impact on the environment, renewable energy hybrid power generation schemes (e.g. fuel cell, wind or solar) have attracted a growing research interest. Photovoltaic (PV) power generation schemes are among the promising renewable energy engineering solutions.

The objectives of the work are given as:

- The main focus is given to modelling, validation and control for PV-solar, and wind generation with grid-connected systems.
- The goal of this work is to model a multi-source alternative DG system consisting of wind turbine(s), PV arrays, and to manage the voltage profile and power flows among the different energy resources in the system.
- Energy management and control of the hybrid system.
- The site is abundant in renewable energy and the hybrid nature increases the reliability and reduces the dependence on one single source.

#### 4. Renewable Energy Resources

Renewable energy resources are the ones that are persistently available and renewing itself with the time. Industrialization and increasing world population has remarked the use of renewable energy resources. Solar power, wind power, biomass, tide power, wave power, geothermal power is known ones [5-6].

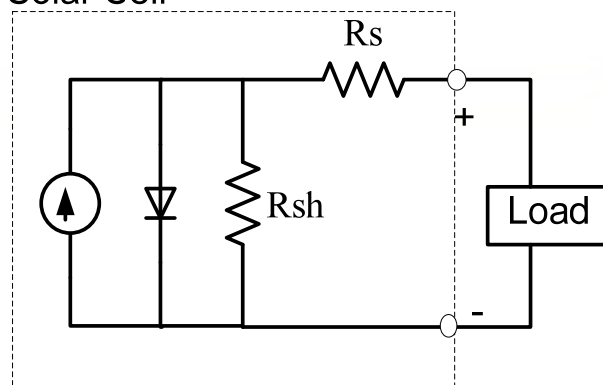
##### 4.1 Photo-Voltaic (PV) solar

PV is the most promising materials in nowadays; it is one of the commonly used renewable energy sources for the grid power system. Solar panels are the medium to convert solar power into the electrical power. Solar panels can convert the energy directly or heat the water with the induced energy [7].

PV (Photo-voltaic) cells are made up from semiconductor structures as in the computer technologies. Sun beam is absorbed with this material and electrons are emitted from the atoms that they are bounded, this release activates a current. Photovoltaic is known as the process between

beam absorbed and the electricity induced. With a common principle and individual components, solar power is converted into the electric power [4-7].

##### Solar Cell



##### DC equivalent circuit

**Figure 1:** Equivalent circuit diagram of a solar PV cell [7]

The photovoltaic cell output voltage is basically a function of the photocurrent which is mainly determined by load current depending on the solar irradiation level during the operation [6, 7].

$$V_c = (A \cdot k \cdot T_c / e) \ln((I_{ph} + I_0 - I_c) / I_0) - R_s \cdot I_c \quad (1)$$

The symbols used are described below

$V_c$ : cell output voltage, V.

$T_c$ : reference cell operating temperature (20 °C).

$R_s$ : series resistance of cell (0.001  $\Omega$ ).

$I_{ph}$ : photocurrent, function of irradiation level and junction temperature (5 A).

$I_0$ : reverse saturation current of the diode ( $2 \cdot 10^{-4}$  A).

$I_c$ : cell output current, A.

$k$ : Boltzmann constant ( $1.38 \times 10^{-23}$  J/K).

$e$ : electron charge ( $1.602 \times 10^{-19}$  C).

##### 4.2 Wind Generation

Wind power systems convert the kinetic energy of the wind into other forms of energy such as electricity. Although wind energy conversion is relatively simple in concept, turbine design can be rather complex. Most commercially available wind turbine uses a horizontal axis configuration with two or three blades, a drive train, including a gear box and a generator and a tower to hold the rotor. Typical sizes for a wind turbine range from 200-750 KW, with electricity produce within a specific scope of wind velocity.

Wind energy involves the conversion of the kinetic energy present in the wind into mechanical energy [1]. The extraction of the wind's kinetic energy is accomplished by a blade-rotor system. The mechanical energy which is in a form of rotation of a shaft connected to the rotor system is then converted to electricity using a generator. Normally a gearbox (planetary or parallel design) is employed between the main shaft and the generator to step-up the shaft's speed to the electric generator [1]. As applied to the solar resource, the wind energy available around the

planet at any instant is quite vast. The doubly fed induction machine is the most widely machine in these days. The induction machine can be used as a generator or motor. With the use of power of the wind, wind turbines produce electricity to drive an electrical generator. Usually wind passes over the blades, generating lift and exerting a turning force. Inside the nacelle the rotating blades turn a shaft then goes into a gearbox. The gearbox helps in increasing the rotational speed for the operation of the generator and utilizes magnetic fields to convert the rotational energy into electrical energy, then the output electrical power goes to a transformer, which converts the electricity to the appropriate voltage for the power collection system. A wind turbine extracts kinetic energy from the swept area of the blades [1,5, 9].

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The power contained in the wind is given by the kinetic energy of the flowing air mass per unit time [5, 7, 8]. The equation for the power contained in the wind can then be written as:

$$P_{air} = \frac{1}{2} (\text{air mass per unit time}) * (V_{\infty})^2 \quad (2)$$

$$= \frac{1}{2} (\rho A V_{\infty}) * (V_{\infty})^2 \quad (3)$$

$$= \frac{1}{2} \rho A (V_{\infty})^3 \quad (4)$$

Although above equations describes the availability of power in the wind, power transferred to the wind turbine rotor is reduced by the power coefficient  $C_p$ .

$$C_p = \frac{P_{wind turbine}}{P_{air}} \quad (5)$$

$$P_{wind turbine} = C_p * P_{air} \quad (6)$$

## 5. Future Operation and Design of Hybrid Energy System

This system may be thought-about for a property hybrid energy system, designed on two modes. One is standalone and different is grid-assisted mode. In complete mode, it attracts power from the wind-solar hybrid energy system. Within the grid-assisted mode, once the hybrid system is unable to feed the facility, it mechanically takes the grid power. If the site-specific knowledge isn't on the market, one could use nearest earth science station knowledge in

planning the system. The system voltage variation, the frequency, wave form and power issue at the time of grid association, should be maintained inside the bounds. One will improve the facility quality relying upon the native conditions. Hybrid energy flow is controlled victimization power electronic converters. This energy would be helpful in several applications like ship power systems, electrical hybrid vehicles, telecommunication industries, rural electrification etc. any R & D enhancements in star PV and wind technologies can scale back the value of renewable energy sources. The value of standard energy resources is increasing each year. This method goes to be economical in future. Besides the value, the environmental edges are possible to facilitate the widespread use and acceptance of those systems.

As mentioned within the previous section, the inclusion of computer science as a part of the energy management system in close to future, guarantees to optimize the operation of hybrid energy. The performance of standard hybrid energy systems may be improved through the implementation of advanced management strategies in an exceedingly centralized system controller. Optimum resource allocation, supported load demand and natural resource forecast, guarantees to considerably scale back the full disbursement of the system. The applying of contemporary management technique to supervise the operation of standard hybrid energy systems permits the employment of the natural resource to be optimized. Advanced management techniques also will improve the performance of such systems by up energy management.

## 6. Conclusions

The hybrid energy systems are recognized as a viable different to grid provide or standard, fuel-based, remote space power provides everywhere the planet. The literature review reveals that, renewable energy based mostly low emission hybrid systems don't seem to be price competitive against standard fuel power systems. However, the requirement for cleaner power and enhancements in energy technologies bear smart potential for widespread use of such systems. Moreover, the agricultural households in industrial and fewer developed countries attach high worth to a reliable, restricted provider of electricity. Community facilities like rural hospitals, schools, telecommunication and water pumping stations will contribute considerably to the welfare of individuals and rural development. Whereas it's recognized that technology will solely be one facet of community development, the renewable energy systems have incontestable the potential to produce support in a number of the essential infrastructure desires in remote and concrete areas for various application.

Although the value reduction and technological development of hybrid energy systems in recent years has been encouraging, still they continue to be an upscale supply of power. To permit the widespread application of this rising technology, there's a requirement for any R & D enhancements in star PV and wind technologies which will scale back the value of hybrid system. the value of standard energy resources is increasing each year,

however the receding trend within the price of renewable energy technologies owing to its widespread use is encouraging issue, protrusive RES system a cost-effective suggests that of power generation in future for several standalone applications. This may finally be all over that the hybrid energy system combining variable speed turbine and PV array generating.

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